MTL SP 91-2

SBIR PROGRAM: DEMONSTRATE, DEVELOP, AND MARKET

ROBERT J. MORRISSEY
TECHNOLOGY INTEGRATION & MANAGEMENT DIVISION

May 1991

US ARMY
LABORATORY COMMAND
MATERIALS TECHNOLOGY LABORATORY

U.S. ARMY MATERIALS TECHNOLOGY LABORATORY
Watertown, Massachusetts 02172-0001

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Mention of any trade names or manufacturers in this report shall not be construed as advertising nor as an official indorsement or approval of such products or companies by the United States Government.

DISPOSITION INSTRUCTIONS

Destroy this report when it is no longer needed.
Do not return it to the originator.

MTL SP 91-2

SBIR PROGRAM: DEMONSTRATE, DEVELOP, AND MARKET

Special Publication by

ROBERT J. MORRISSEY

May 1991

Presented at the Technology Transfer Society Annual Meeting on Preparing the Way: Technology Transfer in the 21st Century, Denver, CO, June 9-11, 1991.

TECHNOLOGY INTEGRATION & MANAGEMENT DIVISION
U.S. Army Materials Technology Laboratory
Watertown, MA 02172-0001

SBIR PROGRAM:
DEMONSTRATE, DEVELOP, AND MARKET

ABSTRACT

The Small Business Innovation Research (SBIR) program was established by Congress in 1982 to spur development of new products and processes by small companies. Congress recognized that while small businesses were the nation's principle source of significant innovations, most federally funded research and development (R&D) had been conducted by large businesses, universities, and federal laboratories. They wanted large federal agencies to set aside 1.25% of their extramural or contract R&D budgets for small businesses under this SBIR program.

Government SBIR funding can only be used for the first two phases of this three-phase program. Phase I is a relatively small research effort to demonstrate the feasibility of the concept involved. Phase II is a main R&D effort expected to result in a well-defined deliverable product or process. SBIR funding is over $400 million a year for the 11 federal agencies that participate in the program. Success occurs when the Phase III commercialization stage is reached and where Government agencies can also procure the SBIR-developed product or process with non-SBIR funding. The Small Business Administration (SBA) surveyed over 800 Phase II projects stemming from the first three years of the program (FY83 through FY85) and found that one-quarter of these firms had achieved Phase III success by the time their Phase II contract had been completed for four years.

This paper describes the SBIR program and explains how it works. It identifies the technological areas of activities and some important programs and opportunities available to assist small firms with their SBIR endeavors. An overview of the U.S. Army Materials Technology Laboratory's (MTL) SBIR program is presented along with a description of their SBIR success stories. They sponsored the first U.S. Army-wide SBIR contractor to successfully reach Phase III. That company has achieved national recognition in the field of braiding advanced composite material products and is well positioned to withstand global competition with patents covering a dozen foreign countries. The SBIR program is innovatively developing and transferring technology into marketplace products today; its contribution to our national interests should increase significantly as we approach and enter the 21st century.

CONTENTS

SBIR PROGRAM: DEMONSTRATE, DEVELOP, AND MARKET

Background and the Law

Congress recognized that while small business was the nation's principle source of significant innovations, the vast majority of federally funded research and development (R&D) had been conducted by large businesses, universities, and government laboratories.[1]

INNOVATIONS INITIATED BY SMALL U.S. FIRMS DURING THE 20th CENTURY[2]

ACOUSTIC SUSPENSION SPEAKERS
AEROSOL CAN
AIRPLANE
ARTICULATED TRACTOR CHASSIS
ARTIFICIAL SKIN
ASSEMBLY LINE
AUTOMATIC FABRIC CUTTING
BAKELITE
BIOSYNTHETIC INSULIN
CATALYTIC PETROLEUM CRACKING
COMPUTERIZED BLOOD PRESSURE CONTROLLER
CONTINUOUS CASTING
COTTON PICKER
DEFIBRILLATOR
DOUBLE-KNIT FABRIC
DRY CHEMICAL FIRE EXTINGUISHER
ELECTRICAL WIRE NUTS
FIBER OPTIC TESTING EQUIPMENT
FLUID FLOW METER
FOAM FIRE EXTINGUISHER
FRONT-END LOADER
GAS CHROMATOGRAPH
GEODESIC DOME
GYROSCOPE
HAND-HELD FLUORSCOPE
HEART PACEMAKER
HEART VALVE
HEAT SENSOR
HELICOPTER
HETRODYNE RADIO
HYDRAULIC BRAKE
LINK TRAINER
NMR SCANNED
NMR SPECTROMETER
OPTICAL SCANNER
ORAL CONTRACEPTIVES
OUTBOARD ENGINE
OVERNIGHT PACKAGE DELIVERY
PERSONAL COMPUTER
PHOTOTYPESETTING
PIEZO ELECTRICAL DEVICES
POLAROID CAMERA
PRECAST CONCRETE
PREFABRICATED HOUSING
PRESSURE SENSITIVE CELLOPHANE TAPE
PROGRAMMABLE COMPUTER
QUICK-FROZEN FOODS
ROTARY OIL DRILLING BIT
SAFETY RAZOR
SIX-AXIS ROBOT ARM
SOFT CONTACT LENSES
SONAR FISH MONITORING
SPECTROGRAPHIC GRID
STEREOSCOPIC MAP SCANNER
STRAIN GAUGE
STROBE LIGHTS
VACUUM TUBE
VARIABLE OUTPUT TRANSFORMER
WINCHESTER DISK DRIVE
XEROGRAPHY
ZIPPER

Congress wanted the larger federal agencies with extramural (contract) R&D budgets of over $100 million to set aside 1.25% of these dollars for small businesses under a new program. This Small Business Innovation Research (SBIR) program was created by the Small Business Development Act of 1982 (Public Law 97-219) with the following objectives:[3]

- To stimulate technological innovation
- To use small businesses to meet federal R&D needs
- To increase private sector commercialization of innovations derived from federal R&D
- To foster and encourage participation by minority and disadvantaged persons in technological innovation*

*The percentage of awards to minority and disadvantaged firms ranged from 8.4% to 12.4% for FY84 through FY87.[4]

1. *Seventh Year Results Under the Small Business Innovation Development Act of 1982.* Small Business Administration, July 1990, p. 2, 14.
2. *A Report to the President.* Small Business Administration, March 1983.
3. *Policy Directive: Small Business Innovative Research Program.* Small Business Administration, June 1988.
4. *Federal Research: Assessment of the Small Business Innovation Research Programs.* General Accounting Office. GAO/RCED-89-39, January 1989, p. 35.

The Act was originally to expire in 1988. In 1986 it was determined that more time was needed to assess the program's effectiveness* and the Act was extended until 1993. The General Accounting Office (GAO) is to report to Congress on the program's Phase III (payoff stage) activities by the end of 1991.[5]

ELEVEN FEDERAL AGENCIES PARTICIPATE IN SBIR PROGRAM

Federal Agency	FY89 Obligations Millions ($)	Percent (%)
Department of Defense (DOD)	233.5	54.1
Health & Human Services (HHS)	79.3	18.4
National Aeronautics & Space Administration (NASA)	51.9	12.0
Department of Energy (DOE)	33.3	7.7
National Science Foundation (NSF)	18.7	4.3
Department of Agriculture (DOA)	3.9	0.9
Department of Transportation (DOT)	3.7	0.9
Environmental Protection Agency (EPA)	3.1	0.7
Department of Education (ED)	2.1	0.5
Nuclear Regulatory Commission (NRC)	1.2	0.3
Department of Commerce (DOC)	1.1	0.2
	431.8	100.0

DoD is by far the largest participating agency. It includes the U.S. Army, Navy, Air Force, the Defense Advanced Research Projects Agency (DARPA), the Defense Nuclear Agency (DNA), and since 1985, the Strategic Defense Initiative Organization (SDIO) (Star Wars).

SOME SBIR POLICIES AND DEFINITIONS

Small Business

An independently owned and operated business of under 500 employees, including affiliates, organized for profit and located in the United States, and which is at least 51% owned by U.S. citizens or lawfully admitted, permanent resident aliens.

Patents

Small business firms normally may retain the principle worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free

*SBIR program funding started out small and gradually increased to the 1.25% level over a 4 or 5 year period, depending upon the agencies' extramural R&D budget.

5. *Proposed Amendments to the Small Business Innovation Research Program.* General Accounting Office. GAO/RCED-89-173, June 1989, p. 10.

license for Federal Government use, and reserves the right to require the patent holder to license others under certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 U.S.C. 205, the Government will not make public any information disclosing a Government-supported invention for a two year period to allow the awardee a reasonable time to pursue a patent.

Annual Solicitations

Each agency shall issue at least one SBIR solicitation annually. Topics shall describe needs in sufficient detail to assist small firms in providing on target responses, but shall not involve detailed specifications to prescribe solutions (hence, the innovation).

Presolicitation Announcements

The Small Business Administration (SBA) issues over 70,000 announcements quarterly to announce forthcoming solicitations with opening and closing dates and the titles of topics to be included. Potential offerors can contact the agencies of interest to obtain copies of their solicitations.

SBIR is a Three-Phase Program

Phase I - Proof of concept/feasibility study
(DoD goal: 6 months, $50,000)

Phase II - Main R&D effort expected to result in a well-defined, deliverable product or process
(DoD goal: 24 months, $500,000)

Phase III - Commercialization/Government procurement

- It is intended that nonfederal capital be used by small business firms to pursue commercial applications of the R&D
- Additionally, Government agencies may procure the product or process developed with non-SBIR funding

SBIR funding can only be used for Phases I and II. Solicitations are for Phase I proposals only, and only firms awarded Phase I contracts are considered for Phase II awards. When evaluating Phase II proposals of approximately equal merit, the provision of a follow-on Phase III funding commitment for continued development from nonfederal sources is given special consideration.

Three basic skills are needed to be successful under the SBIR program: a research skill is needed in Phase I, a development capability for Phase II, and a marketing skill for the final phase. Many small firms do not possess these skills to the degree necessary to be successful under the program, but there are opportunities for assistance available.

ASSISTANCE AND OPPORTUNITIES AVAILABLE

Consultants and Subcontractors

A small firm itself must perform two-thirds of a Phase I effort and one-half of a Phase II contract. Within these limitations, the small firm may employ academic and business consultants and subcontractors.

State SBIR Programs

Many states have programs to assist small firms and individuals with the Federal SBIR programs.[6] The services vary from state-to-state, but may include: proposal preparation assistance or funds, funding grants or loans, and assistance toward Phase III commercialization.

Commercialization Matching System

This system, developed by the SBA, has over 10,000 SBIR projects and 450 capital sources listed in the database. The system provides small firms and potential sources of investment with information about each other. Potential matching selections consider technology and industrial preferences, geographical preferences, and dollar thresholds.

The SBA categorizes and reports SBIR contract awards by technological areas:

SBIR'S 35 TECHNOLOGICAL AREAS

COMPUTER, INFORMATION, ANALYSIS

- 10 - COMPUTER, COMMUNICATION
- 1 - INFORMATION PROCESSING*
- 7 - SIGNAL/IMAGE PROCESSING*
- SYSTEMS STUDIES
- 14 - MATH MODELLING

ELECTRONICS

- 12 - MICROELECTRONICS
- DEVICE PERFORMANCE
- 6 - EQUIPMENT/INSTRUMENTATION*
- 11 - EM RADIATION/PROPAGATION
- MICROWAVE/MM WAVE
- 2 - OPTICAL/LASER*

MATERIALS

- 3 - ADVANCED MATERIALS*
- 15 - PROCESSING/MANUFACTURING*
- 13 - COATINGS/CORROSION*
- PERFORMANCE/FATIGUE*
- FUNDAMENTAL/INSTRUMENTS*

MECHANICS OF VEHICLES/FACILITIES

- HYDRODYNAMICS
- AERODYNAMICS
- ACOUSTICS
- STRUCTURAL PERFORMANCE*
- CONTROL
- MEASUREMENTS*

ENERGY CONSERVATION & USE

- 8 - TRANSPORT SCIENCES
- PROPULSION/COMBUSTION*
- LARGE SCALE USES
- ELECTRIC POWER

ENVIRONMENT & NATURAL RESOURCES

- OCEAN SCIENCE
- 9 - ATMOSPHERIC SCIENCE
- WATER MANAGEMENT
- EARTH SCIENCES
- ENVIRONMENT PROTECTION*

LIFE SCIENCES

- 5 - MEDICAL INSTRUMENTATION
- 4 - BIOTECHNOLOGY/MICROBIOLOGY
- BEHAVIORAL SCIENCES
- PHYSIOLOGY & MISC

- NOTES -

(1) NUMBERS INDICATE TECH AREAS LEADING IN FY83-89 AWARDS

(2) ASTERICKS (*) INDICATE TECH AREAS OF MTL INVOLVEMENT

6. *A Guide to State Supported Small Business Innovation Research Programs.* Small Business Administration.

The SBA surveyed over 800 Phase II projects stemming from the first three years of the program (FY83 through FY85) with the following results:

SBIR PHASE III PROGRESS AND SUCCESS

	Years After Phase II Completed		
	2 Years	3 Years	4 Years
Percentage of Firms Reporting Success	13%	22%	25%

MTL'S SBIR PROGRAM

Although the U.S. Army Materials Technology Laboratory's (MTL) SBIR program only represents 4% of the U.S. Army's program in terms of topics and funding, MTL sponsored four of the 21 firms (or 19%) that were cited for their achievements in an Army Phase III report issued in mid-1990.[7] These four MTL successes will be described below along with three more recent ones, following a brief overview of MTL's SBIR program activities:

OVERVIEW OF MTL'S SBIR PROGRAM ACTIVITIES

Solicitation		Phase I Proposals			Phase II Follow-On		Phase III Success ?		
FY	Topics (No.)	Recd (No.)	Awards (No.)	Winners (%)	Awards (No.)	Conversion * (%)	Yes (No.)	TPD † (No.)	No (No.)
83	7	70	4	5.7	3	75.0	1	-	2
84	4	39	4	10.3	1	25.0	1	-	-
85	5	52	10	19.2	6	60.0	2	3	1
86	9	104	10	9.6	3	30.0	2	1	-
87	13	174	13	7.5	2	15.4	1	1	-
88	11	178	10	5.6	1	10.0	-	1	-
89	1	16	1	6.3	0	0	-	-	-
90.1	6	66	6	9.1	(To Be Determined)		-	-	-
90.2	11	106	11	10.4	-	-	-	-	-
91.1	1	37	2	5.4	-	-	-	-	-
91.2	10	(To Be Determined)			-	-	-	-	-
(11)	78	842	71	8.4	16	30.8	7	6	3

* Percent of Phase I contractors receiving Phase II follow-on contracts.
† To be determined; most are still working on Phase II efforts.

7. *Army Phase III: Small Business Innovation Research Program Review.* U.S. Army Laboratory Command with assistance from TEM Associates, Inc.

MTL awarded 71 contracts (two are pending) to 8.4% of the 842 Phase I proposals submitted on 68 topics in the first 10 DoD SBIR solicitations. They awarded 16 follow-on Phase II contracts to 30.8% of the 52 Phase I contracts granted awards from the FY83 through FY89 solicitations. Three of these Phase II contractors were not successful enough to reach Phase III. Seven of the remaining 13 have achieved at least some Phase III success along with the subcontractor to one of them. Additional winners are expected to emerge from the other six, four of which are still working on Phase II. In fact, three of the seven winners have not completed their Phase II contracts yet. The seven winners along with the successful subcontractor are listed below:

MTL'S PHASE III SBIR SUCCESSES

Solicitation	Company	Thrust of SBIR Development	Phase II Completed
83	U. S. Composites *	Braiding Composites	April 87
84	Universal Energy Systems * and their subcontractor	Diamond-like Carbon Optical Coatings	October 88
	J. A. Woollam Company	Variable Angle Spectroscopic Ellipsometer	
85	Radiation Monitoring Devices *	Composite Inspection Instrument	Pending
85	Materials Sciences	Composite Specimen Designs	January 91
86	Information Research Lab *	Ultrasonic Spectroscopy	December 90
86	Ultramet	Coated Tungsten Powders	Pending
87	Sunrez	Battlefield Damage Repair Kits	Pending

* Cited in U.S. Army Phase III SBIR Program Review.[7]

Each of these Phase III SBIR achievements is described below.

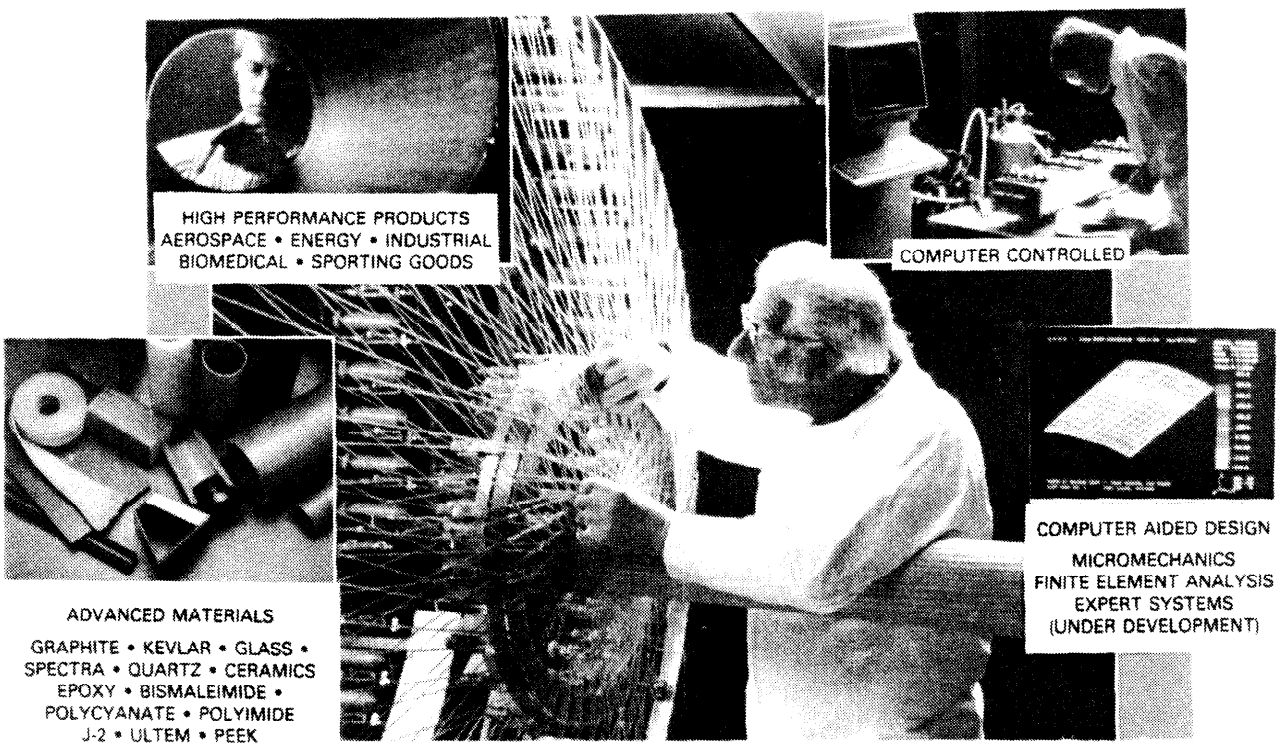
U.S. COMPOSITES CORPORATION, TROY, NY

Braiding Composites

This company went from a two-employee business surviving on sweat equity to become the U.S. Army's first Phase III SBIR success in May 1986 with a license/commercialization agreement with DuPont. They were founded in 1980 to manufacture improved products using advanced composite materials and became interested in textile braiding. Although braiding could readily be automated and offered high production rates at low cost with geometric versatility, its use with composites had been limited due to the lack of a viable means of applying resin to fibers moving in a complex path. The company set out to mitigate these problems under the SBIR program.

U.S. Composites invented a Resin Applicator Ring (RAR), patented in January 1985, that permits effective impregnation of moving fibers with resin in a controlled environment for efficient braiding. During Phase II they built and tested an RAR system with computer controlled resin pumps and installed it on a 64-carrier braider. Prototype specimens of several composites were produced and tested to validate the methodology. A production scale RAR system was then built and installed on a 144-carrier braider at Benet Weapons Laboratory's Composite Laboratory at Watervliet Arsenal in New York. This system was a Phase II deliverable to the U.S. Army. Subscale trail arms for the lightweight howitzer and then full-scale bore evacuators for the 120mm M256 cannon on the Abrams Tank were produced on this braider. This evacuator is expected to replace the current filament-wound type classified evacuators for this cannon because of a fabrication time/cost savings of about 50%. U.S. Composites signed a manufacturing agreement with DuPont in 1989 and began high volume production of a high performance aircraft component.

The company has brought in $795,000 to commercialize their SBIR-developed technology and is raising $2.5 million in new capital for expansion. The resources received include job, economic, and industrial development loans, equity, and matching funds, plus capital equipment supplied by a customer. With patents covering a dozen foreign countries, U.S. Composites is well positioned to withstand global competition. They have performed research on and developed an array of braided composite products for high performance and diverse applications, as illustrated on the following pages.

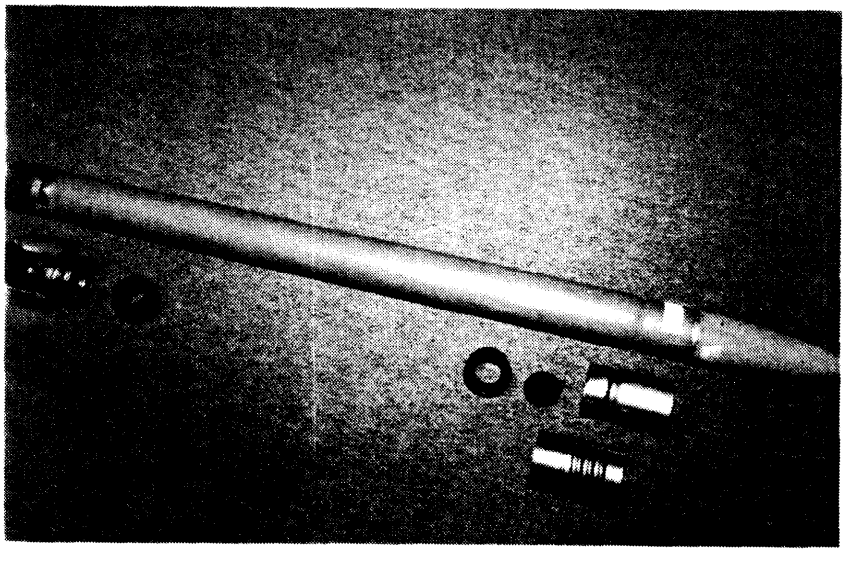


COMPUTER CONTROLLED RESIN IMPREGNATION FOR COMPOSITE BRAIDING

The main purposes of a bore evacuator (shown below) are signature reduction and to allow the hot gases to escape safely without harming personnel.

BRAIDED FIBERGLASS BORE EVACUATOR FOR ABRAMS TANK CANNON

Shown below is the overbraided composite rocket motor case that was developed by U.S. Composites under a U.S. Navy contract to meet insensitive munitions requirements at low cost. The U.S. Navy exhibited this at a 1989 common defense meeting of about 20 countries. Redstone Arsenal buys many of these rockets for the U.S. Army.



2.75-INCH OVERBRAIDED COMPOSITE ROCKET MOTOR CASE

SBIR PHASE III ACCOMPLISHMENTS

Customer	Braided Product Applications
Army - AMCCOM	Bore Evacuator for M256 Abrams Tank Cannon Trail Arms for M198 Lightweight Howitzer
Army - MICOM	Anti-Tank Weapon Launch Tubes RAR System/Computer Controls for Braider
Army - TROSCOM	Reinforced Elements for Composite Bridging
Navy - Underwater Systems	Towed Array Components
Navy - Ordinance Station, Indian Head, MD	2.75 inch Overbraided Rocket Motor Case exhibited at 1989 Common Defense Meeting - 20 nations Motor Case - Sea Petrel Supersonic Target Missile RAR System/Computer Controls for Braider
Navy - ONR & DARPA	Conformable High Pressure Gas Hose
Air Force - NASP JPO	High Temperature Composite Fasteners for National Aerospace Plane (1989 Phase I SBIR Project)
DuPont - Composites Division	High Volume Production of Aerospace Component for commercial and military markets
McDonnell Douglas	Launch Tube for Improved Dragon Missile
Olin Rocket Research	Rifle-Launched Assault Weapon (RLAW) Tubes
Atlantic Research	Maverick Rocket Motor Case
Honeywell - Ordinance Division	Launch Tubes and Related Components
LTV Missiles - Electronics	Preforms for Carbon/Carbon Composites
General Electric - Aircraft Engine Division	Hydraulic and Fuel Line Tubes
Chrysler - Accustar	Energy Absorbing Steering Column Tubes
General Electric - Inland Division	Suspension Components
General Electric - Plastics Division	Co-Preg Braiding with Thermoplastics
Dow Chemical	Co-Preg Braiding with Polycyanates for 350°F/Wet Use and Low Observable Applications
Sikorsky	Helicopter Control Rods
Corning Glass	High Temperature Composites
Israel Military Industry	RAR System/Computer Controls for Braider
General Dynamics, Ft. Worth	Aircraft Ducts, Fuel Lines, Hat Stiffeners
Several Medical Field Companies	A Variety of Medical Instruments and Disposable Devices

UNIVERSAL ENERGY SYSTEMS, INC., DAYTON, OH

Diamond-Like Carbon Coatings for Optical Systems

Universal Energy Systems (UES) developed diamond-like carbon (DLC) coatings to solve problems associated with erosion of optical systems of airborne vehicles (rain, insects) and tactical ground vehicles (sand), as well as the problems involving optical systems operating in saltwater spray and chemically corrosive environments. Wright-Patterson AFB contracted UES to explore electronics applications of the DLC coating process,

which has been patented. UES has a continuing production contract with Lasermike (see chart below) and has a similar larger continuing production contract with a major defense contractor under negotiation. UES has sold DLC coated products to 17 customers.

CUSTOMER	APPLICATIONS
U.S. ARMY MTL	TRIBOLOGY (FRICTION & WEAR)
LASERMIKE	HeNe LASER WINDOWS
LIBBY FORD GLASS	AUTOMOBILE WINDOWS
BIO RAD	OPTICAL WINDOWS
TOSOH (JAPAN)	OPTICAL DISKS
SHERFIELD COMPANY	MACHINE TOOLS
PTICAL FILTER COMPANY	OPTICAL FILTERS
MOELLER MFG. COMPANY	OPTICAL FILTERS
MIDWEST OPTICAL LAB	EYE GLASSES
MONARCH MARKING SYSTEMS	THERMAL PRINTING HEADS
DATA ASSOCIATES	APPLICATION UNKNOWN
MORTON THIOKOL	INFRARED MATLS (ZnSe & ZnS)
MARTIN MARIETTA	SOLAR CELLS
WRIGHT-PATTERSON AFB	MISSILE N/C, CANOPIES & TAILLIGHTS
GENERAL DYNAMICS	F-16 FIGHTER CANOPIES
U.S. ARMY AVSCOM	CANOPIES & TAILLIGHTS
U.S. ARMY MICOM	MISSILE NOSECONES

J. A. WOOLLAM COMPANY (SBIR SUBCONTRACTOR), LINCOLN, NE

Variable Angle Spectroscopic Ellipsometer (VASE)

The DLC films produced by UES (described above) were characterized by a VASE and infrared spectroscopy. The VASE was developed by J. A. Woollam Company and the prototype VASE was a Phase II deliverable to MTL. The company has won three Phase I and one Phase II SBIR awards based upon the VASE's capabilities. They have also produced custom-made VASE's for thin film optical characterization, R&D, and/or quality control (QC) applications with an average sale price of $100,000 each. They have sold 11 VASE's and have six orders under negotiation. The sales involve:

CUSTOMER	APPLICATIONS
NASA - LEWIS	ELECTRONIC MATERIALS R&D
SOLAR ENERGY RES. INST.	SOLAR CELL MATERIALS R&D
BAUSCH & LOMB	OPTICAL COATINGS PRODUCTION
3M	SPACE GROWTH/ORGANIC COATINGS
IBM	COMPUTER DISK ANALYSIS
GENERAL MOTORS	ELECTRONIC MATERIALS R&D
LINKOPING TECH INST., SWEDEN	ORGANIC FILM RESEARCH
NASA - CASE WESTERN UNIV.	SPACE EXPOSED MATERIALS STUDY
ARIZONA STATE UNIV.	CRYSTAL GROWTH MONITOR
EASTMAN KODAK	PHOTO RECEPTOR QC
AIRCO - SOLAR COATINGS DIV.	ENERGY EFFICIENT COATINGS

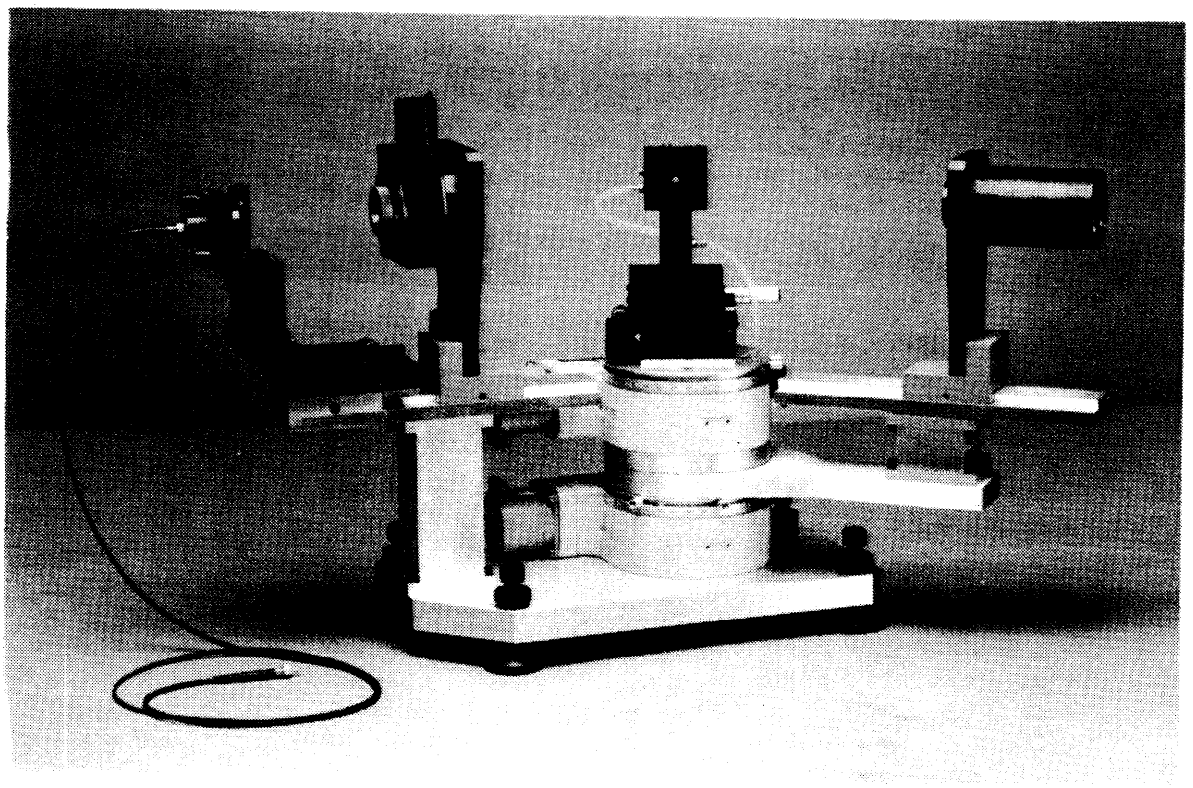
The VASE is illustrated below:

FEATURING:

- MODULAR IN SITU AND EX SITU SYSTEMS
- COMPUTER CONTROL OF ANGLE OF INCIDENCE AND WAVELENGTH
- REAL-TIME ACQUISITION AND DATA ANALYSIS
- FRIENDLY, SOPHISTICATED SOFTWARE

TO MEASURE:

- FILM THICKNESS IN MULITLAYER STACKS
- OPTICAL CONSTANTS OF FILMS AND BULK MATERIALS
- SURFACE AND INTERFACE ROUGHNESS, ALLOY FRACTIONS
- INPLANTATION DAMAGE



VARIABLE ANGLE SPECTROSCOPIC ELLIPSOMETER (VASE)

RADIATION MONITORING DEVICES, WATERTOWN, MA

Composite Inspection Instrument

MTL began spearheading the development of thick organic composite materials for ground vehicle applications some years ago. These materials exhibited a 25% weight reduction at no loss in ballistic protection, when demonstrated via the composite hull tested on the Bradley Fighting Vehicle (BFV). MTL recognized that manufacturing such thick composites would require a new nondestructive inspection technique for quality assurance. This was the SBIR topic Radiation Monitoring Devices (RMD) addressed with the goal of developing an instrument to measure the fiberglass plies in composite armor panels. They developed a portable system based upon radiation backscatter techniques, but a weak radiation source hindered validation tests and MTL expanded the scope of measurement capabilities. The original goal should be met soon.

Meanwhile, RMD is using this SBIR technology on new spin-off instruments being sold or developed for different applications. An on-line glass analyzing system is being installed in the RCA color TV picture tube plant in Indiana, now owned by Thompson Consumer Electronics. This system is capable of quality assurance testing of over 80,000 tubes per week to prevent radiation from being emitted from the television sets. The first prototype was installed there in June 1989 and several more systems were installed later.

RMD has a second SBIR spin-off application being explored to measure the composition of brakeshoe linings, which affects brake function and life with associated liability implications. Three major brake companies are considering purchasing this new system that could be installed in facilities around the world for quality assurance tests.

The latest spin-off is a very small instrument to conveniently measure the amount of lead paint found on the walls and ceilings of Federally owned housing units. This system is expected to reduce the time required to obtain these measurements under the current methods by a factor of ten. RMD plans to fill orders for three units by late 1991. The system has a potential annual market of several hundred units at around $10,000 to $12,000 per unit. RMD is discussing distribution with companies active in lead paint testing.

MATERIALS SCIENCES CORPORATION, SPRING HOUSE, PA

Composite Specimen Designs

This SBIR effort was aimed at facilitating the introduction of advanced composite materials into U.S. Army/DoD systems and stimulating the growth of these materials in industry. Materials Sciences Corporation (MSC) conducted a combined analytical and experimental verification effort and developed improved specimen designs to test composite materials. The experimental phase was performed by the University of Wyoming, the subcontractor. The conditions considered included: tension, compression, in-plane shear, combined stress, and interlaminar shear and fracture. The results are being incorporated into MIL-HDBK-17, a structural properties handbook for composite materials that is becoming the authoritative source of such data. The development of

this handbook is being coordinated with the American Society for Testing Materials (ASTM) and numerous other national advocacy groups for composites. In April 1990 the Federal Aviation Administration (FAA) began funding a three-year follow-on (Phase III) effort to incorporate certification requirements of small and transport airplanes and helicopters into MIL-HDBK-17B (*Polymer Matrix Composites*). This is the only document that the FAA has endorsed containing composite materials properties for use in aircraft design without further substantiation by the applicant.

INFORMATION RESEARCH LABORATORY, NORTH DARTMOUTH, MA

Ultrasonic Spectroscopy

Information Research Laboratory (IRL) developed a high-resolution, nondestructive evaluation (NDE) system based on ultrasonic spectroscopy and supported by innovative signal processing and pattern recognition methods. The basic system is comprised of a personal computer, a pulser/receiver, and a digital oscilloscope. User-friendly software was developed for computerized analysis of flaws to meet various inspection requirements. The Phase III success involves sales of the software package to the 12 customers listed below.

- Carpenter Technology Corp.
  Reading, PA
- Conam Nuclear, Inc.
  Richmond, CA
  (representing Zetec, Inc.
  Issaquah, WA)
- Industrial Materials Research Inst.
  National Research Council of Canada
  Boucherville, Quebec, Canada
- EG&G Rocky Flats
  Golden, CO
- J. A. Jones Applied Research Co.
  Charlotte, NC
  (representing Electric Power Research Inst.,
  Charlotte, NC)
- Karta Technology, Inc.
  San Antonio, TX
- Informetrics
  Silver Spring, MD
- Innovative Sciences, Inc.
  San Leandro, CA
- McDonnell Aircraft Co.
  St. Louis, MO
- McDonnell Douglas Helicopter Co.
  Mesa, AZ
- Rohr Industries, Inc.
  Chula Vista, CA
- University of Patras
  Patras, Greece

ULTRAMET, PACOIMA, CA

Coated Tungsten Powders

Ultramet developed a process for uniformly coating metallic and ceramic powder particles (as small as 5.0 microns in diameter) with metallic or ceramic matrices. The resulting composite powder is consolidated through an innovative high pressure, low

temperature/time process, during which no appreciable grain growth occurs (grain growth increases the contact area between tungsten particles and tends to increase potential crack initiation sites). The product is a composite material of substantially higher strength, uniformity, and fracture toughness than similar materials produced by standard liquid phase sintering techniques. MTL's interest is to obtain tungsten alloys with improved ballistic properties for penetrators. The depleted uranium alloys used in penetrators has potential health and environmental hazards.

Ultramet has produced a versatile process to virtually coat any powder material with any matrix material(s) in any proportion. Their sales related to this development have totaled about $150,000 over the past year. They have also been working with the U.S. Navy on applying this technology to Phalanx ammunition. Ultramet announced this process development to selected members of the powder metallurgy community in late February 1991 and received over 100 responses within a month. Ultramet is also negotiating a joint agreement with one of the world's largest cutting tool manufacturers. This SBIR-developed process is expected to have a large impact on both the powder metallurgy and cutting tool fields, both of which are multi-billion dollar markets.

SUNREZ CORPORATION, EL CAJON, CA

Battlefield Damage: Field Repair Kits

Phase III success was thrust upon Sunrez in January 1991 by the chemical warfare threat of the Persian Gulf War. At that time Sunrez was only halfway through their 24 month Phase II contract to produce effective field repair kits for battle damaged vehicles. However, this was not altogether unreasonable since Sunrez was to deliver three sets of 50 repair kits to MTL during Phase II for field evaluations. The main goal is to seal holes in battle damaged vehicles to restore chemical agent resistance and moisture protection. The project includes a bonded fiberglass patch for larger holes and patch putty containing fiberglass fibers for smaller holes, and is applicable to both composite and metallic structures. The kits must be inexpensive, easy to apply, harden in minutes, and applicable to soiled or oily surfaces. The resin includes an innovative curing agent sensitive to weak ultraviolet light so that the patches will cure even in bad weather. A small ultraviolet light is being developed so a crew member can patch a hole from inside the vehicle during a chemical or nuclear attack.

MTL had informed appropriate U.S. Army personnel about this project's potential. The Army Battlefield Damage Assessment and Repair Group planned to assist with the field evaluations. Ultimately, the U.S. Army Tank-Automotive Command (TACOM) issued an order for 1,000 kits and 1,000 tubes of patch putty on January 21, 1991. By hiring more help and working around-the-clock, Sunrez filled the order in a week. Then in mid-February, two weeks before the cease-fire, TACOM placed another order for 5,000 kits and 5,000 tubes of patch putty. This order was subsequently modified to 5,000 tubes of patch putty and filled.

This repair kit has many potential applications involving the repair of aircraft, ground vehicles, boats, pontoons, and pipes, for example. Sunrez's Vice President, Dr. W. Novis Smith, was issued a patent in March 1988 on *Advanced Composite Armor.*

The repair patch can restore some level of ballistic protection, depending upon the patch thickness and design. Sunrez's field repair kit and some commercial spin-off products are illustrated below:

CONCLUDING REMARKS

SBIR is a high-risk, high-technology program with intense competition that seems to be meeting its objectives remarkably well. Technology transfer is built into the design of the program with its demonstrate-to-develop-to-market phases, and various programs and opportunities are available to assist small firms with all three phases.

The SBIR program teems with innovative technological ideas and developments and has produced a significant amount of notable products and processes to the benefit of successful entrepreneurs, our nation, and other countries. A host of additional worthy innovations will undoubtedly evolve from the program as we approach and enter the 21st century.

ACKNOWLEDGMENTS

The successes attained on MTL's SBIR program are due in no small measure to the diligence of MTL's scientists and engineers who develop the solicitation topics, evaluate the proposals, and serve as Authorized Government Representatives (AGR) to technically monitor and assess the SBIR contracts. They also serve as *product champions* to help achieve maximum benefit from SBIR-developed innovations within the U.S. Government. Their contributions have been vital to the success of MTL's SBIR program and are accordingly acknowledged.